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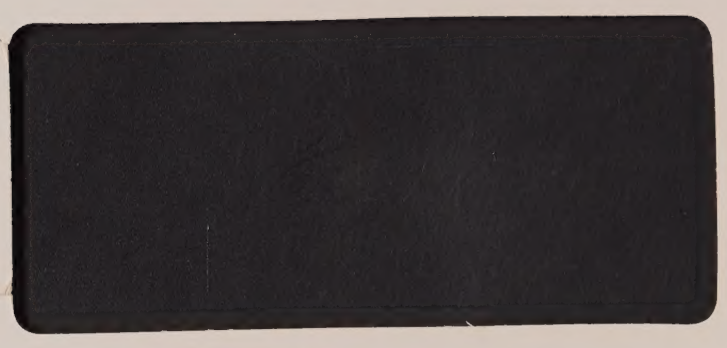

C.1

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INSTRUCTION MANUAL

TEST OSCILLATORS

C772A & X772A

#1

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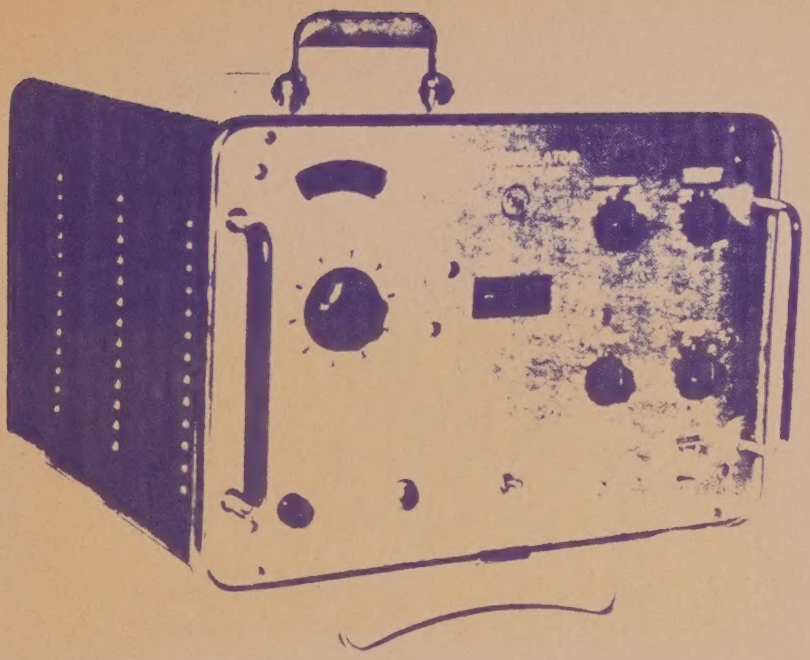

Test Oscillator, Model X772A

ALL CHARACTERISTICS APPLY TO BOTH UNITS,
MODELS C772A & X772A
UNLESS OTHERWISE SPECIFIED

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NOTE: MODELS C772A AND X772A SIGNAL SOURCES

The klystron supplied with the Models C772A and X772A Signal Sources is either a type 6390, 6236 or 5721. The cathode current for these klystrons is 22 - 24 MA maximum with the modulation switch in CW position. This current can be measured by inserting a 0 - 25 MA DC milliammeter in place of the jumper connection from J1 to J2 on the front left of the modulator circuit board. In the event of low RF output power, the cathode current should be checked and re-adjusted to 22 - 24 MA by means of potentiometer R130 on the modulator circuit board. When cathode current can no longer be adjusted to this value, the klystron should be replaced. Normal klystron operating life is approximately 500 hours. Refer to the instruction manual for the procedure pertaining to klystron replacement.

The 10-100 MW specified power output of these units is obtained under CW operation. This is also the peak pulse or square wave output power. Under pulse or square wave operation, some klystrons may exhibit erratic starting over small portions of the klystron reflector mode at one or two points in the frequency band. This phenomena covers a very narrow band of frequencies (normally only a few megacycles wide) and does not appear in CW operation. This occurrence is indicated by erratic or zero output signal at the particular frequency. It can be minimized or shifted in frequency by optimum tracking of the klystron reflector voltage (see Par. 4.4, Section IV) or by rotating the klystron tube for optimum operation. In extreme cases, particularly if this occurs at an often used frequency, it may be necessary to replace the klystron.

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ERRATA SHEET

TEST OSCILLATORS, MODELS S, L, C, X, 772A

Model S 772A - Serial No. 231 up.
Model L772A - Serial No. 235 up.
Model C772A - Serial No. 318 up.
Model X772A - Serial No. 334 up.

Change R118 from 200K ohms to 150K ohms
±5.0%, ½ Watt.

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SECTION I
DESCRIPTION

1.1 GENERAL. The FXR Types C772A and X772A Test Oscillators are designed as compact and versatile power sources for a wide variety of microwave measurements. Among the desirable features of these instruments are:

a. Accurate, direct reading, single knob frequency control.

b. Maximum power output of 10-100 mw providing considerably more output than signal generators operating in the same frequency range.

c. A built-in level-set attenuator.

d. Internal pulse and square wave modulation.

e. Provision for external pulse or frequency modulation.

f. Frequency of the external cavity klystron is determined by the position of a non-contacting choke plunger, resulting in decreased wear and lower R.F. noise.

g. Klystron reflector voltage is automatically tracked with the plunger position, providing optimum operation throughout the band.

h. A vernier drive and large illuminated frequency dial for accurate and reproducible control of frequency settings.

i. Stability assured by a built-in regulated power supply, precision built cavity, and temperature compensated klystron tube.

1.2 ELECTRICAL CHARACTERISTICS.

Table 1
FREQUENCY RANGE

TYPE NO.	FREQUENCY
C772A	3950-8200 Mc/sec.
X772A	7000-11000 Mc/sec.

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1.3. FREQUENCY ACCURACY. ±1% absolute.

1.4 POWER OUTPUT. 10 - 100 mw CW maximum over frequency range into a matched load. Variable through a built-in level-set attenuator (uncalibrated).

1.5 TYPES OF OUTPUT. CW, internal pulse or square wave modulated, external pulse or external FM.

1.6 INTERNAL MODULATION. Pulse or square wave, frequency variable from approximately 450 to 1800 cps. Pulse width variable between 1 to 15 microseconds approximately.

1.7 EXTERNAL PULSE MODULATION. Positive pulse required of approximately 20 volts amplitude across 100 K ohms. Pulse width from 0.5 microseconds to square wave.

1.8 EXTERNAL REFLECTOR MODULATION. Sine wave or sawtooth, frequency modulation sensitivity approximately 100 Kc/volt.

Table 2
TYPE CONNECTORS

R.F. Output	Type N Female
Pulse Modulation	Type BNC Female
Reflector Modulation	Type BNC Female

1.9 POWER SOURCE. 115/230 volts A.C. (units are wired for 115V unless otherwise requested) 50/60 cps, 200 watts.

Table 3
MECHANICAL CHARACTERISTICS

Width	16"
Height	11"
Depth	15"
Weight	50 Lbs.

SECTION II
OPERATING INSTRUCTIONS

2.1 GENERAL. All controls and terminals necessary for normal operation are located on the front panel of the instrument.

2.2 CONTROLS.

2.2.1 ON. Pilot light, fan, and all tube filaments are operated when the line switch is turned on. A 30 second thermal time delay relay prevents immediate operation of the high voltage power supply. Closing of the time delay relay is indicated by the illumination of the R.F. frequency dial. The unit should be allowed a 15 minute warm-up period if accurate measurements are desired.

2.2.2 FREQUENCY. Sets the R.F. frequency of the microwave oscillator, as read directly from the illuminated frequency dial, to an accuracy of ± 1%.

2.2.3 R.F. ATTENUATION. Adjusts the level of R.F. output power. The front panel markings correspond to an attenuation of approximately 8 db per division. Unless maximum power output is required, the unit should be operated with the attenuator withdrawn one half division or more. This will result in increased stability, particularly if the oscillator is operated into a mismatched load or at the ends of its frequency range.

2.2.4 MODULATION. CW position provides continuous oscillation of the klystron. EXT. PULSE position allows the klystron to be triggered by a positive external pulse or square wave of 20 volts minimum amplitude. PULSE and SQUARE WAVE positions provide internal triggering of the klystron. EXT. REFL position allows the klystron to be frequency modulated when swept by an external sawtooth or sine wave.

2.2.5 MODULATION FREQUENCY. Varies the frequency of the internal pulse and square wave modulation between approximately 450 and 1800 cps. The dual concentric knobs allow fine tuning of the modulator frequency.

2.2.6 PULSE WIDTH. Varies the width of the internal pulse modulation between approximately 1 and 15 microseconds.

2.3 TERMINALS.

2.3.1 R.F. OUTPUT. Type N jack at which R.F. output of the microwave oscillator is provided.

2.3.2 PULSE MODULATION. Jack provided for external pulse or square wave modulating voltage when modulation switch is set to EXT PULSE. On internal modulation positions, the pulse or square wave modulation can be obtained here for triggering an external high impedance load.

2.3.3 REFLECTOR MODULATION. Jack provided for frequency modulation of the klystron when the modulation switch is set to EXT REFL.

SECTION III
THEORY OF OPERATION

3.1 GENERAL. The major components of the FXR Type 772A Test Oscillators can be divided into three sections: (1) the power supply; (2) the modulator; (3) the R.F. circuitry. The power supply and the modulator are shown schematically in Figure 1. Figure 2 is a schematic diagram of the R.F. circuitry.

3.2 THE POWER SUPPLY. The power supply consists of a 1850 volt electronically regulated supply for the klystron cathode, grid and reflector voltages, and a 150 volt VR tube regulated supply for the modulator.

3.2.1 HIGH VOLTAGE SUPPLY. The klystron voltages are developed across the high voltage secondary of power transformer T101, and through the silicon voltage doubler, CR101 thru CR112. The regulator circuit consists of the parallel pass tubes (V102 and V103), a control tube (V104), and a series string of reference tubes (V105, V106, V107, V108, V109, and V110). The full regulated voltage (negative 1600 volts) is applied to the reflector tracking circuit. The klystron cathode voltage (negative 1000 volts) is tapped from the junction of V106 and V107. Thus the reflector tracking system voltage is negative with respect to the klystron cathode voltage by the 600 volt drop across the four series VR tubes (V107, V108, V109, and V110).

3.2.2 MODULATOR SUPPLY. The modulator supply voltage is developed across the low voltage secondary of power transformer T101, and through the silicon bridge rectifier, CR113-CR116. The output is taken across the voltage regulator tube, V101.

3.3 THE MODULATOR. The klystron (V115) used in the FXR Type 772A Test Oscillators is modulated through a sensitive control grid. The voltages applied to this grid are developed in the modulator circuit board.

3.3.1 CW OPERATION. When the modulation switch is set to either CW or EXT REFL positions, the klystron grid is biased sufficiently positive with respect to the cathode to allow continuous oscillation of the klystron. The bias circuit consists of R130, R135, and R136, and is set at the time of installation of the klystron.

3.3.2 SQUARE WAVE OPERATION. When the modulation switch is set to SQUARE WAVE position, plate voltage is applied to the free-running multivibrator, V113. The square wave output of the multivibrator is fed into the first stage of the cathode coupled amplifier, V111. The second stage, which has been switched

from a cut-off to a conducting state, contains the klystron grid biasing resistor, R130, as its plate load. When the positive half of the square wave is applied to the grid of the first stage of V111, the second stage is cut-off. Thus the plate of the second stage, together with the klystron control grid, is returned to its CW voltage. When the negative half of the square wave is applied to the grid of the first stage of V111, the second stage conducts, driving both its plate and the klystron grid negative. The klystron then ceases to oscillate.

3.3.3 PULSE OPERATION. When the modulation switch is set to PULSE position, both the free-running multivibrator (V113) and the one-shot multivibrator (V114) receive plate voltage. The differentiated output of the free-running multivibrator is used to trigger the one-shot multivibrator. The output pulse of the one-shot multivibrator is fed into the first stage of the cathode coupled amplifier (V111), thus driving the klystron in the identical manner as described in Section 3.3.2.

3.3.4 EXTERNAL PULSE OPERATION. When the modulation switch is set to EXT PULSE position, the input to the first stage of the cathode coupled amplifier (V111) is connected to the PULSE MODULATION jack on the front panel. Application to this jack of a positive pulse or square wave from an external source will result in pulse modulation of the klystron.

3.3.5 REFLECTOR MODULATION. When the modulation switch is set to EXT REFL position, the klystron reflector is connected through a coupling capacitor to the REFLECTOR MODULATION jack on the front panel. Application to this jack of a sine wave or sawtooth voltage from an external source will result in frequency modulation of the klystron.

3.4 THE R.F. CIRCUITRY. The R.F. circuitry provides the output of the Type 772A Test Oscillators and can be divided into four sections: (1) the klystron; (2) the cavity; (3) the reflector tracking system; (4) the R.F. attenuator. Figure 2 is a schematic diagram of the R.F. circuitry.

3.4.1 THE KLYSTRON. The 6390 or 5721 klystron can be used in both the C772A and X772A Test Oscillators. The 6236 klystron may be substituted for the 6390 or 5721 klystron in the C772A Test Oscillator. These klystrons are all of the external cavity type.

3.4.2 THE CAVITY. A three-quarter wavelength coaxial cavity with a movable, non-contacting plunger determines the R.F. output frequency of the klystron. The cavity and plunger are designed to suppress oscillation at frequencies other than

those desired. A cam drive is used to obtain a linear frequency dial which can be easily read and interpolated.

3.4.3 THE REFLECTOR TRACKING SYSTEM. The C772A uses one reflector mode to cover its frequency range while the X772A Test Oscillator uses two reflector modes to cover its frequency band.

Table 4
KLYSTRON REFLECTOR MODES

Type No.	Frequency Range	Reflector Mode	Approximate Reflector Voltage
C772A	3950- 8200 mc/sec	2-3/4	50-550
X772A	7000- 9000 mc/sec	3-3/4	150-350
X772A	9000-11000 mc/sec	4-3/4	150-300

A linear potentiometer (R153) is tracked with the cavity plunger to derive the optimum reflector voltage throughout the band. The tracking potentiometer is tapped at a point corresponding to the frequency at which the reflector mode is switched (X772A only). A cam driven microswitch (SW3) sets up the correct reflector voltages for each mode. Protective diodes (CR117-CR121) prevent the klystron reflector from going positive with respect to the cathode.

3.4.4 THE R.F. ATTENUATOR. The R.F. attenuator consists of the R.F. output coupling in a cut-off tube, thus allowing for variation of the power extracted from the cavity. It should be noted that at maximum coupling, the resonant frequency of the cavity will be shifted by a few megacycles. The full power extracted from the cavity is made available at the R.F. output jack. For maximum operating stability, this output should be fed into a matched load, or the attenuator should be withdrawn one-half dial division or more.

SECTION IV
MAINTENANCE

CAUTION

DANGEROUSLY HIGH VOLTAGES ARE USED IN THIS INSTRUMENT. TURN OFF POWER SWITCH AND DISCONNECT POWER PLUG BEFORE REMOVING INSTRUMENT FROM ITS CABINET. DISCHARGE ALL CAPACITOR TERMINALS AND AND DISCONNECT ONE POWER LEAD FROM THE FAN BEFORE SERVICING THE INSTRUMENT.

4.1 GENERAL. Conservative design and the use of quality components should minimize the maintenance problems experienced with these instruments. However, replacement or aging of tubes or other components may necessitate some adjustments, provisions for which have been incorporated in the units.

4.2 REMOVAL FROM CABINET. The entire unit can be removed from the cabinet by the following procedure:

a. Turn off the power switch and disconnect the power plug from the line.

b. Remove the four screws holding the aluminum molding to the cabinet and detach the aluminum molding.

c. Remove the four binding head screws at the upper and lower left and right corners.

CAUTION

DO NOT REMOVE ANY OTHER SCREWS FROM THE FRONT PANEL.

d. Remove the two screws holding the chassis to the bottom of the cabinet.

e. Slowly remove the front panel and chassis from the cabinet. Take care not to damage the klystron tube base at the lower right side of the unit.

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f. Discharge all capacitor terminals and disconnect one of the two power leads coming from the fan.

4.3 REPLACING KLYSTRON TUBE. It is suggested that, before inserting a new klystron tube, the following replacement procedure be practiced with the old klystron. The klystrons used in these instruments are quite fragile, and any unusual strains on the tube may result in breakage. Refer to Figure 3 while observing the following replacement procedure:

a. Remove the tube socket from the klystron base.

b. Unscrew the knurled cap from the cavity.

c. Holding the klystron tube base, gently remove the klystron, together with the knurled cap, bearing, and rubber sleeve, from the cavity. Pull straight out, applying no sideward pressure to the tube. A slight initial rotation may facilitate this extraction.

d. The reflector lead should NOT come out with the klystron. In the event it does come out, push it back, making certain it seats squarely in the bakelite support.

e. Remove the rubber sleeve, bearing, and knurled cap from the old klystron, and insert them on the new klystron, as shown in Figure 3.

f. Carefully start inserting the new klystron into the cavity, making certain that the klystron upper grid fits snugly and smoothly within the inner conductor fingers.

g. Continue inserting the klystron, pushing the klystron lower grid into the outer conductor fingers.

h. Seat the front part of the klystron lower grid squarely against the three seating pins in the cavity outer conductor. Careful and concentric seating of the klystron is necessary for proper operation of the unit.

i. Seat the rubber sleeve against the rear part of the klystron lower grid, as shown in Figure 3.

j. Screw a few turns of the knurled cap on to the cavity, but do not tighten down on the klystron.

k. Replace the klystron tube socket.

l. Remove the soldered jumper between the terminal posts marked J1 and J2 on the front left of the modulator circuit board, and insert a 0-25 Ma D.C. milliammeter.

m. Turn the unit on and allow it to warm up for several minutes.

n. With the modulation switch set to EXT REFL, feed a 50-100 volt amplitude sawtooth into the reflector modulation jack on the front panel.

o. Set the R.F. attenuator for zero attenuation and feed the R.F. output into a crystal detector. A 10 db pad placed before the detector will provide matching and prevent burnout of the crystal.

p. Vary the R.F. frequency slowly over the band and observe the detected klystron mode pattern of the output on a sensitive oscilloscope, using the sawtooth as the horizontal sweep on the oscilloscope. It may be necessary to readjust the reflector tracking to keep the mode pattern on the scope (see Section 4.4 below).

q. If the mode pattern appears weak or drops out at any point, carefully rotate the klystron slightly to obtain optimum operation throughout the band. Keep the klystron lower grid seated squarely against the seating pins in the cavity.

r. Observe the klystron cathode current, as read by the milliammeter, across the band. Set R130 on the modulator board for a maximum cathode current of 23 Ma.

s. If difficulty is experienced in finding a position of the klystron for stable operation throughout the band, turn off the unit and reinsert the klystron at a different orientation.

t. When an optimum position of the klystron is obtained, hold the klystron in this position and tighten down the knurled cap until it seats, making certain that the bearing is concentrically seated in the counterbore within the knurled cap.

u. Readjust the reflector tracking (see Section 4.4 below).

4.4 REFLECTOR TRACKING ADJUSTMENT. After replacement or aging of the klystron tube, it may be necessary to readjust the reflector tracking system potentiometers R155 and R157 (also R154 and R156 on the X772A). The following procedure should be observed:

a. With the modulation switch set to EXT REFL, feed a 50-100 volt amplitude sawtooth into the reflector modulation jack on the front panel.

b. b. Set the R.F. attenuator for approximately one-half of a dial division of attenuation and feed the R.F. output into a crystal detector. A 10 db pad placed before the detector will provide matching and prevent burnout of the crystal.

c. Vary the R.F. frequency slowly over the band and observe the detected klystron mode pattern of the output on a sensitive oscilloscope, using the sawtooth as the horizontal sweep on the oscilloscope.

d. Set the frequency dial at the low frequency end of the band (3950 Mc/sec. on the C772A; 7000 Mc/sec. on the X772A), and decrease the sawtooth sweep amplitude to approximately 10 volts.

e. Center the detected output, as seen on the scope, at the peak of the mode pattern by adjusting R157.

f. Set the frequency dial at the high frequency end of the band (8200 Mc/sec. on the C772A; 11,000 Mc/sec. on the X772A).

g. Center the detected output, as seen on the scope, at the peak of the mode pattern by adjusting R155.

STEPS "h" thru "k" APPLY TO X772A ONLY

h. Set the frequency dial at the low frequency end of the second reflector mode, or slightly before the click of the microswitch is heard (slightly above 9,000 Mc/sec.).

i. Center the detected output, as seen on the scope, at the peak of the mode pattern by adjusting R156.

j. Set the frequency dial at the high frequency end of the first reflector mode, or slightly after the click of the microswitch is heard (slightly below 9,000 Mc/sec.).

k. Center the detected output, as seen on the scope, at the peak of the mode pattern by adjusting R154.

l. Vary the R.F. frequency slowly over the band and make any slight adjustments necessary in R154, R155, R156, and R157 for optimum tracking.

m. Remove the reflector sweep signal and set the modulation switch to SQUARE WAVE position.

n. Vary the R.F. frequency slowly over the band and observe the detected square wave on the oscilloscope. This step is necessary because some klystrons will not pulse properly along certain portions of the reflector mode.

o. Make any slight adjustments necessary in R154, R155, R156, and R157 for optimum square wave operation throughout the frequency band.

p. Tighten the locking nuts on R154, R155, R156, and R157.

q. If a new klystron has been installed, observe that the klystron cathode current in CW position varies between 20-23 Ma over the frequency band (see Section 4.3 above). Remove the milliammeter from terminal posts J1 and J2 on the modulator circuit board and resolder the jumper between these posts.

4.5 BEAM VOLTAGE ADJUSTMENT. R119 on the bakelite portion of the power supply chassis sets the klystron beam voltage. This is usually set for 1000 volts. Some klystrons may perform better, particularly in the X772A, with a beam voltage setting of 1250 volts. Do not increase the beam voltage above 1250 volts. Always monitor beam current (see Section 4.6 below) when adjusting beam voltage.

4.6 BEAM CURRENT ADJUSTMENT. The klystron beam current is monitored by replacing the soldered jumper between the terminal posts marked J1 and J2 on the front left of the modulator circuit board with a 0-25 Ma D.C. milliammeter. This meter will measure the total of the klystron resonator current plus the klystron control grid current. Maximum allowable beam current, with the modulation switch in CW position, is 25 Ma. It is usually unnecessary to draw more than 23 Ma maximum for satisfactory operation. This current is controlled with R130 on the modulator circuit board.

4.7 SYMMETRY ADJUSTMENT. R106 on the modulator circuit board adjusts the symmetry of the square wave output of the free-running multivibrator, V113.

This should be set for symmetry, as observed on an oscilloscope, at a modulation frequency of 1000 cps.

4.8 PULSE WIDTH ADJUSTMENT. R132 on the modulator circuit board adjusts the maximum pulse width of the one-shot multivibrator, V114. This should be set for a maximum pulse width of 15 microseconds, as observed on an oscilloscope.

4.9 R.F. FREQUENCY ADJUSTMENT. Replacement of the klystron tube may result in a shift in the R.F. output frequency of the unit. The frequency may be shifted by loosening the locking nut on the threaded, nylon-tipped bearing that rides on the cam drive. Clockwise rotation of the threaded bearing will result in a lower frequency of oscillation; counter-clockwise rotation in a higher frequency. The bearing should be adjusted until the frequency of oscillation agrees with the dial reading. The locking nut should be retightened after this operation.

SECTION V
PARTS LIST

REFERENCE SYMBOL	DESCRIPTION
C101, C102	2μfd-2000V DC Plastic Type OE20-205
C103	2μfd-2500V DC C-D Type TJU-25020J
C104	0.1μfd-400V DC Plastic Tubular
C105	0.1μfd-1000V DC Plastic Tubular
C106	20μfd-450V DC Electrolytic C-D Type AO-460
C107, C108	0.01μf-1000V DC Plastic Tubular
C109	0.5μf-1500V DC C-D Type TJH-15005.
C110	24μμf-500V DC Mica 5%
C111	0.1μf-1600V DC Plastic Tubular
C112, C116	0.5μf-400V DC Plastic Tubular
C113, C114	1000μμf-500V DC Mica 5%
C115	39μμf-500V Mica 5%
C117	0.005μf-600V Plastic Tubular
R101	500K-100K Dual Concentric Pot
R102, R103	10K 1W
R104	430K 1/2W
R105	2.7K 1W
R106	250K Pot Type AB JLU-2541
R107	560K 1/2W 5%
R108	4K 10W Ward Leonard Type 10X4K
R109, R110	100 Ohm 1/2 Watt
R111, R112	47 Ohm 1/2W
R113, R114	1.5K 1/2W
R115	1M 1W
R116	56K 1/2W
R117	330K 5W 5%
R118	200K 1/2W 5%
R119	100K Pot Type AB JLU-1041
R120	220K 1W
R121	100K 2 W 5%
R122	10K Pot Type AB JU-1031
R123, R124	30K 10W Ward Leonard Type 10X30K
R125, R133	100K 1W
R126	1M 1/2W

REFERENCE SYMBOL	DESCRIPTION
R127, R128	100K 1/2W
R139	3.3M 1/2W 5%
R130	5K Pot Type AB JLU-5021
R142	3.3K 1W
R132	25K Pot Type AB JLU-2531
R134, 135, 136	50K 10W Ward Leonard Type 10X50K
R137, R138	6.8K 1W
R151	220K 1/2W
R153	200K Tapped FXR Special
R154	500K Pot (X772A)
R155	50K Pot (C772A); 500K Pot (X772A)
R156	500K Pot (X772A)
R157	100K Pot Type AB JLU-1041
L101	8 Hys 65 Ma
CR101-CR121	Silicon Rectifier Int. Rect. Type 5E4
T101	Power Transformer
T102	Filament Transformer
V101, 105, 106	OA2
V102, V103	6CA7
V104	6SJ7
V107, V108	OD3
V109, V110	
V111	6J6
V113, V114	6BQ7A
V115	Klystron Type 6390, 6236, 5721
SO1, SO2	Receptacle Cannon Type DA-15S
PL1, PL2	Plug Cannon Type DA-15P
SW1	Power Switch SPST Type ST12A
SW2	Rotary Switch Centralab Type PA-2023
SW3	Microswitch SPDT
RE1	Relay Amperite Type 115N030T
	Fuse Type AGC 3 Amp
	Pilot Light Type 47
	Dial Light 6W 110V
	Fan Blade Torrington Type 0-520-4
	Fan Motor Barber Colman Type DYAB 571-2

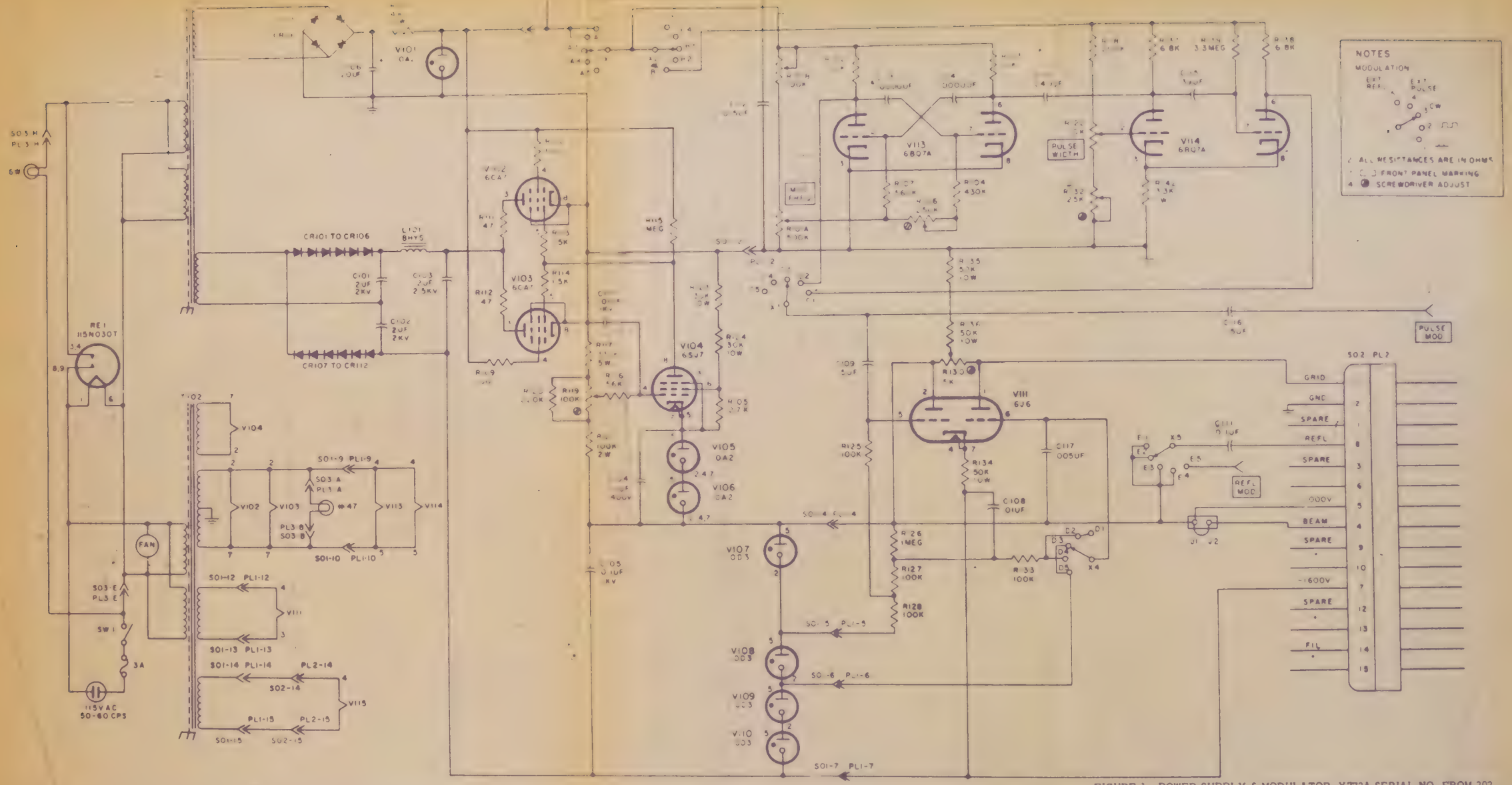

FIGURE 1. POWER SUPPLY & MODULATOR X772A SERIAL NO. FROM 202
C772A SERIAL NO. FROM 195

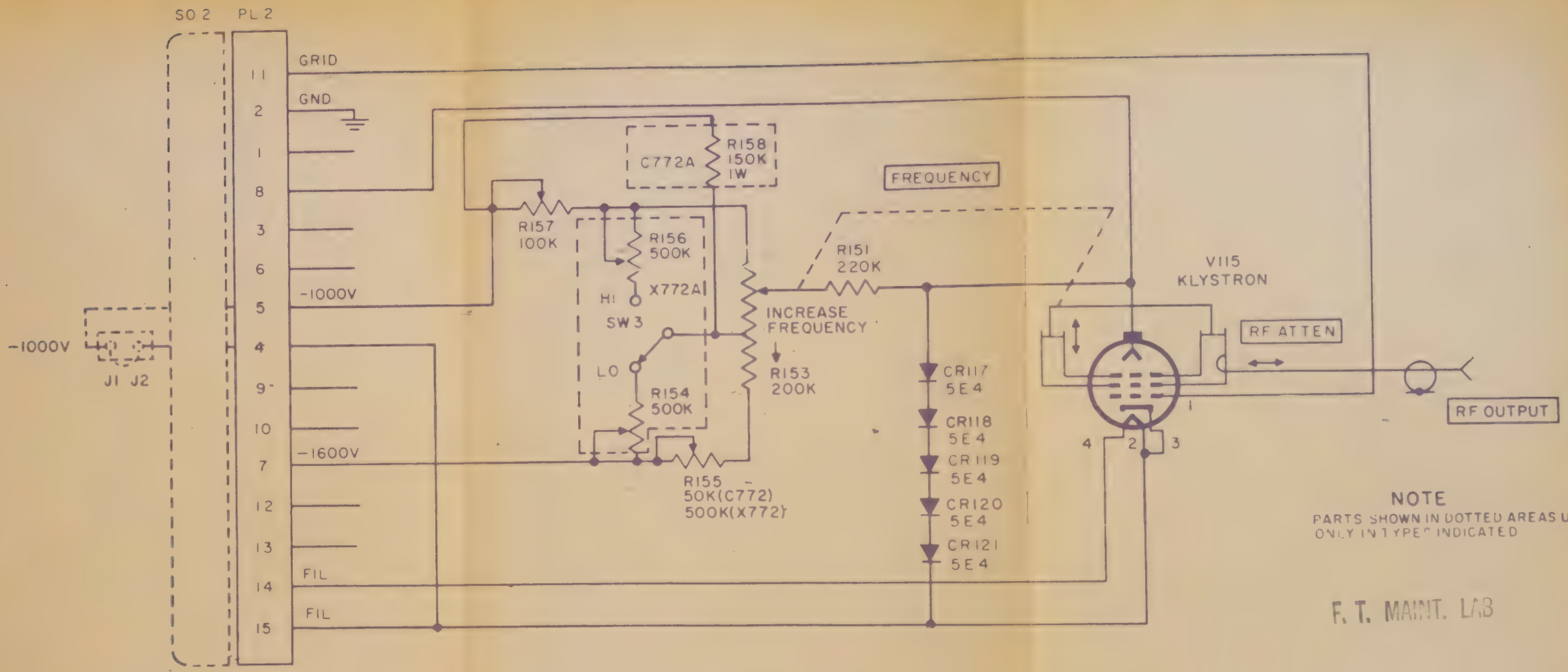

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FIGURE 2. RF CIRCUITRY C772A SERIAL NO. FROM 195
X772A SERIAL NO. FROM 202

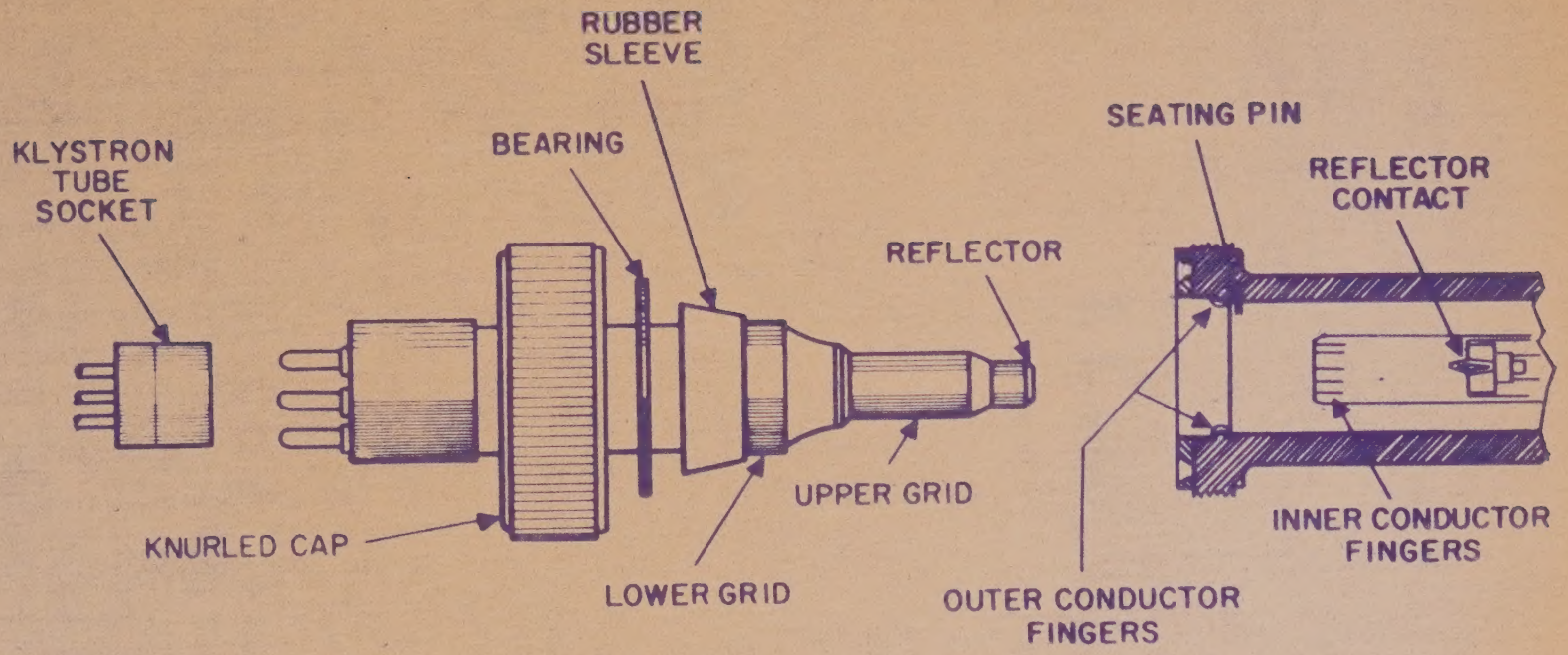

FIGURE 3. INSTALLATION OF KLYSTRON

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